SAVANNAH-FERNANDINA WATERWAY.

LETTER

FROM

THE ACTING SECRETARY OF WAR,

TRANSMITTING,

With a letter from the Chief of Engineers, copies of reports of Capt. O. M. Carter, Corps of Engineers, in relation to the preliminary examination and survey of the Savannah-Fernandina Waterway.

JANUARY 5, 1892.—Referred to the Committee on Rivers and Harbors and ordered to be printed.

WAR DEPARTMENT,
Washington, December 8, 1891.

SIR: I have the honor to inclose herewith a letter from the Chief of Engineers, dated December 2, 1891, together with copies of reports from Capt. O. M. Carter, Corps of Engineers, dated November 25, 1890, and November 25, 1891, respectively, of preliminary examination and survey of "the inside route between Savannah, Ga., and Fernandina, Fla., with a view of obtaining a steamboat channel of 7 feet depth at mean low water," made by him in compliance with the provisions of the river and harbor act of September 19, 1890.

Very respectfully,

L. A. GRANT,
Acting Secretary of War.

The SPEAKER OF THE HOUSE OF REPRESENTATIVES.

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., December 2, 1891.

SIR: I have the honor to submit herewith copies of reports, dated November 25, 1890, and November 25, 1891, respectively, upon preliminary examination and survey of "the inside route between Savannah, Ga., and Fernandina, Fla., with a view of obtaining a steamboat channel of 7 feet depth at mean low water," made by Capt. O. M. Carter, Corps of Engineers, in compliance with provisions of river and harbor act approved September 19, 1890

To establish a continuous channel not less than 7 feet deep at mean low water between Savannah, Ga., and Fernandina, Fla., will require dredging and other work of channel improvement at four points, Romerly Marsh, Mud River, Little Mud River, and Jekyl Creek. The cost of the work is estimated as follows:

Romerly Marsh (Habersham Creek route)	$53,000
Mud River	16,000
Little Mud River	1,000
Jekyl Creek (completion of existing project)	35,000
Total	105,000

The proposed improvements of Romerly Marsh and Mud River will require to be maintained after completion, and the annual cost of such maintenance is estimated as follows:

Romerly Marsh	$500
Mud River	4,000
Total	4,500

Captain Carter states:

Irregular and inadequate appropriations will greatly increase the cost of the work and delay its completion, and it is therefore recommended that unless the total sum required for its completion, viz, $105,000, can be appropriated at one time no appropriation for the work may be made.

The maps, being very large and not suitable for printing by photolithography, are retained in the office of the Chief of Engineers.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

Hon. REDFIELD PROCTOR,
Secretary of War.

PRELIMINARY EXAMINATION OF INSIDE ROUTE BETWEEN SAVANNAH, GEORGIA, AND FERNANDINA, FLORIDA, WITH A VIEW OF OBTAINING A STEAMBOAT CHANNEL OF SEVEN FEET DEPTH AT MEAN LOW WATER.

UNITED STATES ENGINEER OFFICE,
Savannah, Ga., November 25, 1890.

GENERAL: In compliance with Department letter dated September 20, 1890, I have the honor to submit the following report of a preliminary examination of "the inside route between Savannah, Ga., and Fernandina, Fla., with a view of obtaining a steamboat channel of 7 feet depth at mean low water."

The location of this route is shown by a dotted line on Coast Survey charts Nos. 156 and 157, to which I respectfully refer for details. Throughout the greater portion of the route are found ample widths and depths for steamboat navigation. Depths less than 7 feet at mean low water are found at the following places: (1) Romerly Marsh; (2) Mud River; (3) Little Mud River; (4) Jekyl Creek; (5) The Dividings. In Frederica Creek, about 1 mile above Frederica Landing, the channel is obstructed by oyster beds. Some slight shoaling has also taken place at the mouth of Adams Creek.

At two of the localities, viz, Romerly Marsh and Jekyl Creek, work has already been done by the United States. There is now a mean low-water depth at the former place of 4.8 feet, and at the latter of 5.5 feet.

For detailed descriptions of the condition of these localities, I respectfully refer to my last annual report.

At Mud River there is for nearly 4 miles a mean low-water depth of only about 4 feet. Near the southern end of Little Mud River there is a shoal with a depth of about 6 feet at mean low water. At "The Dividings," near the mouth of Crooked River, there is a depth of about 5.5 feet at mean low water.

I have not been able to obtain any reliable information relative to the value of the commerce passing through this route. Two steamers per week ply on this route between Fernandina and Savannah, fourteen per week between Brunswick and river points, and one daily between Brunswick and Fernandina. Vessels are often towed over portions of this route to avoid rough weather at sea, and it is also navigated by many small craft carrying rice, naval stores, oysters, and fish. The value of the commerce passing through this route has been variously estimated at from $200,000 to $400,000 per annum.

Two important points on this route have already been deemed worthy of improvement by the United States, viz, Romerly Marsh and Jekyl Creek, and I am of the opinion that for all of the reasons stated the obstructions to navigation at the other points mentioned should also be removed.

Among other advantages to be derived from the proposed improvement are that steamers now plying on this route could run on schedule time, and vessels that now have to go to sea could be towed to coastwise ports over this route, thus avoiding the risk of encountering strong weather at sea.

The military importance of this route has already received attention, and need not be stated here.

The estimated cost of surveys upon which to base plans and estimates of improvements, is $1,000.

Very respectfully, your obedient servant,

O. M. CARTER,
First Lieutenant, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

(Through Col. William P. Craighill, Corps of Engineers, Division Engineer, Southeast Division.)

[First indorsement.]

U. S. ENGINEER OFFICE,
Baltimore, Md., November 28, 1890.

Respectfully submitted to the Chief of Engineers.

In view of the facts and reasons set forth in the report of the local engineer of November 25, 1890, and of my own personal knowledge, I consider the inside route between Savannah, Ga., and Fernandina, Fla., worthy of improvement, including the present and prospective needs of commerce.

WM. P. CRAIGHILL,
Colonel, Corps of Engineers.

SURVEY OF INSIDE ROUTE, BETWEEN SAVANNAH, GEORGIA, AND FERNANDINA, FLORIDA, WITH A VIEW OF OBTAINING A STEAMBOAT CHANNEL OF SEVEN FEET DEPTH AT MEAN LOW WATER.

UNITED STATES ENGINEER OFFICE,
Savannah, Ga., November 25, 1891.

GENERAL: In accordance with the requirements of section 17 of the river and harbor act of September 19, 1890, and instructions from the Chief of Engineers, dated November 29, 1890, I have the honor to submit herewith my report upon the survey of the "inside route between Savannah, Ga., and Fernandina, Fla., with a view of obtaining a steamboat channel of 7 feet depth at mean low water," together with a project for its improvement and an estimate of the cost of the same. A brief description of the aim of the proposed improvement and some facts relating to its commercial importance are given in my report upon the preliminary examination, dated November 25, 1890, to which I respectfully refer.

The location of this route is shown by a dotted line on current Coast Survey Charts Nos. 156 and 157, to which reference is respectfully made for details in connection with the following description. The route leaves the Savannah River by St. Augustine Creek and following Wilmington River, reaches Romerly Marsh, through which two routes exist—the old one through Romerly Marsh Creek, very crooked and narrow, and almost impracticable at low water, and the new route through Dead Mans Hammock Creek and the dredged cut connecting the same with Wassaw Creek, through the latter and Odingsell River to Adams Creek where it joins the first route. From Romerly Marsh the route traverses the following streams, or portions of them, viz, Adams Creeek, Vernon River, Ogeechee River, Florida Passage, and Bear River; then crosses St. Catherines Sound and follows North Newport River (or Walburg Creek), Johnsons Creek, and South Newport River into Sapelo Sound. In all parts of the route just described, south of Romerly Marsh, the depths exceed 7 feet at mean low water, ranging generally from 10 to 20 feet and often exceeding the latter depth. On leaving Sapelo Sound, the most serious obstruction of the entire route is found in the long stretch of shallow water in Mud River. For a distance of over 3.5 miles the depth is less than 7 feet; the mean depth is 5.8 feet, and the least depth 4.8 feet, all referred to mean low water. From Mud River the channel follows New Teakettle Creek, crosses Doboy Sound, and enters North River, thence through a portion of Rockdedundy River, reaches Little Mud River, in which there is a shoal of small extent carrying slightly less than 7 feet at mean low water. Crossing Altamaha Sound the channel continues through Buttermilk Sound and Frederica Creek into St. Simon Sound. About 1 mile north of Frederica Landing the channel is narrow and is partially obstructed by oyster beds.

Entering Jekyl Creek from St. Simon Sound two shoals are encountered, one just outside the entrance and the other inside, at the point where the creek widens. The least mean low-water depths on those shoals are 4.8 feet on the former and 5.3 feet on the latter. The route crosses St. Andrews Sound by a detour seaward around the middle ground, and thence by way of Cumberland River and Cumberland Sound reaches Fernandina, Fla.

From Jekyl Creek southward the depths are ample, exceeding in

most places 10 feet at mean low water, and navigation is easy, except at one point, known as "The Dividings," at the mouth of Crooked River. At that point a sharp turn of more than 100 degrees is made by the channel in passing Horseshoe Shoal. The least channel depth is, however, fully 7 feet at mean low water, and greater depths are found on either side of the shoal. Were the channel properly marked by ranges and buoys no difficulty in navigating it should be experienced.

The distance from Savannah to Fernandina by the inside route just described is about 160 miles.

Touching at Darien en route increases the distance by about 20 miles, and at Brunswick by about 12 miles.

The survey of the inside route was made under my direction in April and May, 1891, by Mr. George W. Brown, assistant engineer.

Detailed surveys were made at the following points: Romerly Marsh, Mud River, Little Mud River, Jekyl Creek, and "The Dividings."

The methods employed in the survey are similar to those described in my report upon the survey of the inside route between Doboy Sound and Sapelo Sound, dated October 5, 1891, to which I respectfully refer.

ROMERLY MARSH.

Wassaw Creek route.—With a view to determining the best route for an improved channel through Romerly Marsh, two lines were surveyed, viz, the present channel through the dredged cut and Wassaw Creek and a route from Romerly Marsh Creek through Habersham Creek, the head of which is separated by a narrow strip of marsh land from Odingsell River.

The first-named route was opened under the direction of Congress between the years 1883 and 1886 by the dredging of a cut through the marsh between Dead Mans Hammock Creek and Wassaw Creek, and by deepening the latter at Shoals No. 1, No. 2, and No. 3. For details in reference to its construction, I respectfully refer to the annual reports of the Chief of Engineers, U. S. Army. The total length of continuous cut is 4,117 feet, 3,547 feet of which are through solid marsh and 570 feet at the head of Wassaw Creek. The cut is from 90 to 110 feet wide at the low-water and about 140 feet wide at the high-water line. The surface of the marsh is at about the level of mean high water, except at the southern end of the cut, where it joins Wassaw Creek in a low marsh, scarcely half of which rises above the level of mid-tide. The depth of water in the cut exceeds 7 feet at only one point, 1,100 feet from the northern end, where it is 7.1 feet. The mean depth throughout the cut is 5.8 feet, and the least depth is 5.2 feet, at points about 800 feet from the northern end and 600 feet from the southern end. For a length of about 200 feet on Shoal No. 3, and 800 feet on Shoal No. 2 the depth is less than 7 feet, the minimum mean low-water depths being 6.7 feet on the former and 6.3 feet on the latter.

The material at the bottom of the cut is mud, clay, and fine sand, mud and sand predominating. The banks are of mud and a little sand, except at Dead Mans Hammock, where they are of clear, fine sand. At Shoal No. 3 the bottom is of sand and clay or hard mud. At Shoal No. 2 it is softer, containing more mud.

The mean range of tide in the cut, as approximately determined by only a few observations, is about 6.8 feet. The tidal currents are very irregular, owing to the fact that the tides from Wassaw Sound and Ossabaw Sound meet near the southern end of the cut. Current observa-

tions were made on May 8, during a spring tide with a range of 9.1 feet, the mean tidal range being 6.8 feet. The results obtained do not therefore correspond to mean tidal conditions. At low water, on the date considered, an area of slack water prevailed throughout the southern half of the cut and the upper two-thirds of a mile in Wassaw Creek, from which area ebb currents still ran slowly toward the north and south. An hour later the currents had been reversed, and slow flood currents were running both in the cut and the creek toward a slack-water area at the point where the cut and the creek meet. For a time the current from the north then overpowers that from the south and drives the area of slack water down the creek about 3,000 feet, where it remains until about half tide, when the low marshes and mud flats at the head of Wassaw Creek become flooded and the currents flow with increased velocities from both directions to cover the greatly increased area, and meet at the mouth of the large branch of Wassaw Creek about 600 feet from the cut.

Those conditions prevail until nearly high water, when the current from Wassaw Creek predominates for a time and drives the slack-water area back into the cut about 1,000 feet. Half an hour after high water the currents change and until half ebb divide at the mouth of the large branch of Wassaw Creek and flow in both directions toward the sea. After this Wassaw Creek alone drains its large branch, as well as the southern end of the cut, and the slack-water area moves gradually northward until it reaches the middle of the cut. At one hour before low water, however, the currents again divide at the mouth of the large branch, and finally disappear at slack low water. In the cut the maximum flood velocity was found to be about 2.6 feet per second at three hours after high water, with a bottom velocity of about 2 feet, and the maximum ebb velocity to be about 1.2 feet per second at two hours after high water, with a bottom velocity of about 1 foot. In Wassaw Creek below the large branch the maximum flood velocity was only 0.9 of a foot per second at one hour before high water, with a bottom velocity of 0.7 of a foot, and the maximum ebb velocity was 1.85 feet per second at two and one-half hours after high water, with a bottom velocity of 1.7 feet. The condition of slack water which prevails at the head of Wassaw Creek and the southern end of the cut for at least one-half of the time is a fruitful source of shoaling, and the pocket which existed at the head of the creek with a low-water depth of 12 feet when the cut was opened, has shoaled so that the present depths are only from 5 to 6 feet. Shoaling has also taken place throughout the entire cut, owing partly to the degradation of the banks and partially to the material brought in by the strong flood currents which the weaker ebb is unable to remove. The mean depth in the cut at its completion was 7.2 feet, and the least depth 6.1 feet. At present the mean depth is but 5.8 feet and the least depth 5.2 feet, showing a fill in the cut alone of over 20,000 cubic yards of material. The cut has widened at the high-water line by from 5 to 25 feet in the northern half, and from 20 to 40 feet in the southern half. The shoaling was very rapid during the first two years after the completion of the cut. Since then it has been slower, but continuous at the rate of about 0.2 of a foot per year.

The permanent improvement of this channel can be accomplished only by continuous dredging, since there is no feasible method of changing the tidal conditions so as to promote natural scour.

The quantities of material necessary to be removed by dredging to give a depth of 7 feet at mean low water in a channel 50 feet wide at

the bottom, with side slopes not greater than 1 on 2, are as follows, viz:

	Cubic yards.
In the cut proper	35,000
At Shoal No. 3	4,000
At Shoal No. 2	5,000
Shoal between Nos. 2 and 3	3,000
Total	47,000

Estimating the cost of dredging at 25 cents per cubic yard in place, and allowing 15 per cent for engineering and contingencies, the total cost of the improvement would be, in round numbers, $13,500.

There is, however, no reason to believe that the new channel would be any more permanent in character than it has proved to be in the past. The total amount of material to be dredged, as given above, represents approximately the amount of filling that has taken place during the past five years. Should the shoaling continue at the same rate, there would be required an annual expenditure of from $2,000 to $3,000 to maintain the improved channel.

ESTIMATES.

Dredging 47,000 cubic yards in place, at 25 cents	$11,750.00
Engineering and contingencies, 15 per cent	1,762.50
Total	13,512.50
Estimated annual expenditure for maintenance, $2,500, interest at 5 per cent on	50,000.00
Aggregate	63,512.50

Habersham Creek route.—The second route surveyed through Romerly Marsh is by way of Habersham Creek, and a proposed dredged cut through the narrow strip of marsh between the head of the creek and Odingsell River. Habersham Creek branches from Romerly Marsh Creek about 1.5 miles west of the mouth of Dead Mans Hammock Creek and extends nearly due south, almost cutting across the narrowest portion of the marshes lying between Romerly Marsh Creek and Odingsell River. This route will form the shortest available one between the mouth of Romerly Marsh Creek and the head of Adams Creek, with greater probabilities of self-maintenance than any other. The distance between the above-mentioned points via the present cut and Wassaw Creek is 8.3 miles; through the "Old Marsh" route it is 4.3 miles; while by the Habersham Creek route it would be only 3.3 miles.

The main stem of the creek is 4,400 feet long, it is nearly straight, and varies in width from 75 to 150 feet at the low-water and from 125 to 200 feet at the high-water line. The mean low-water channel depths vary between 3.8 feet and 7.9 feet, the average depth being 6 feet. The bottom and banks are composed principally of soft or stiff mud.

The creek has two branches, the larger of which continues toward the south, with an average width of 80 feet and a low-water depth of from 1 foot to 4 feet, and heads at a point distant only 1,000 feet from Odingsell River. The mean range of tide in Habersham Creek has never been accurately determined. The observations made give it between 6.8 and 7 feet.

Flood currents prevail until a short time after high water and ebb currents until a short time after low water. Velocities were observed only during flood tide, and were found to reach a maximum of about 1.2 feet per second, with a bottom velocity of about 1 foot. It is probable that the ebb velocities do not differ much from the flood.

The improvement of this route would require the deepening of the main stem of the creek by the removal of about 12,000 cubic yards of material by dredging, and the opening of a dredged cut following approximately the course of the larger branch and cutting through the marsh on the shortest line to Odingsell River by the removal of about 120,000 cubic yards of material, making a total of 132,000 cubic yards.

If a less tortuous route be selected, the total amount of material to be removed by dredging would be increased to about 150,000 cubic yards. The changes in the tidal conditions that would follow the opening of the proposed cut are difficult to predict, owing to the meager information available in regard to the relative elevations and slopes of the water surface at different stages of the tide. One determination of elevations made April 7, 1891, shortly after half flood, gave the elevation of the water surface in Odingsell River as 6.4 feet above mean low water, and that at the head of the large branch of Habersham Creek as 6.1 feet above the same plane. At the head of the main stem of the creek it was 6.3 feet. An elevation corresponding to that in Odingsell River would therefore probably be found near the middle of the main stem of the creek. Those conditions, if maintained after the opening of the cut, would cause the tides to meet near the middle of the main stem of the creek. A single determination at only one stage of tide cannot, however, be supposed to render true mean results which may be quite different from those given.

There is at the head of Romerly Marsh Creek an area of low marshes and mud flats forming a large tidal reservoir. It is possible that were the cut opened it and Habersham Creek would be called upon for service in filling and emptying this basin in conjunction with Romerly Marsh Creek, thus determining the meeting of the tides at the junction of those two creeks—a condition favorable for the maintenance of ample depths in the creek and cut. Those advantages of tidal flow would be augmented by the closing of the Old Marsh route at a point near Adams Creek, so that the flow to and from the tidal basin before mentioned might be forced through the new channel. This would require the construction of a closing dam about 200 feet long, rising to a height of 3 feet above mean high water in an average mean low-water depth of about 5 feet.

Such a dam of log or brush mattresses loaded with stone or shells up to mean low water and of stone and shells alone above that level would cost about $8,000.

ESTIMATES.

Dredging, 150,000 cubic yards, in place, at 25 cents	$37,500
Mattresses, 4,000 square yards, at 75 cents	3,000
Stone, 1,200 cubic yards, at $3.50	4,200
Shells, 1,000 cubic yards, at $1	1,000
Total	45,700
Engineering and contingencies, 15 per cent	6,855
Estimated annual expenditure for maintenance $500, interest at 5 per cent on	10,000
Aggregate	62,555

The construction of the closing dam may not be necessary, in which case the total cost, including engineering and contingencies, would be reduced to $53,555. The route described would be shorter than the present route through Wassaw Creek by about 5 miles, and would possess the additional advantage of not requiring frequent expenditures for maintenance.

Had not the opening of the Wassaw Creek route been made mandatory by Congress that route would not have been selected by the engineer. In view of all of the foregoing, it is therefore recommended that the present route be abandoned, and the route through Habersham Creek be selected for improvement.

MUD RIVER.

The present channel between Doboy and Sapelo sounds passes through Mud River and New Teakettle Creek. In the latter ample depths are found, ranging from 10 to 20 feet, but in Mud River extensive shoals are encountered, with minimum depths at various points in the best channel of from 4.7 to 5.3 feet at mean low water. The distance through Mud River from the head of New Teakettle Creek to Sapelo Sound is about 4 miles. The widths are excessive, being about 5,800 feet at the mouth, widening to 6,400 feet 2 miles above, and then gradually narrowing to about 1,700 feet just below the entrance to New Teakettle Creek. The present channel, after leaving New Teakettle Creek, crosses the river over a shoal 1,500 long, with a minimum depth of 4.8 feet, and enters a deep pocket 3,000 feet long close to the western shore. Then follows a distance of 11,000 feet, in which the depth is less than 7 feet, the minimum depth being 5.3.

At the mouth of the river there is another shoal 4,500 feet long with a minimum depth of 5.2 feet. East of the channel are wide mud flats with depths of but 1 or 2 feet and with large areas showing above mean low water. Near the mouth there is a deep pocket along the eastern shore, but it shoals into the mud flats just described and is rapidly filling up, former depths of 16 feet being reduced to present ones of only 8 or 9 feet.

The material composing the river bottom is very soft mud, rendered sticky in places by the admixture of clay. The mean range of tide in Mud River, as approximately determined by the limited number of observations available, is 7.5 feet. The tidal currents are of moderate velocity, and near the upper mouth of New Teakettle Creek are very irregular. Their characteristics are exhibited in the following table:

Tidal hours.	Stage.	Mouth New Teakettle Creek.	New Teakettle Creek.	Mud River above New Teakettle Creek.	Mud River below New Teakettle Creek.
XII	L. W	Slack water	Slow ebb	Slack above; slow ebb below.	Slow ebb.
I		Moderate flood branching N. and S. in Mud River.	Moderate flood	Slow flood	Moderate ebb above; slow flood below.
II		Strong flood branching N. and S. in Mud River.	Strong flood	Moderate flood	Moderate ebb above; moderate flood below.
III	Half flood.	do	do	Strong flood	Slack above; moderate flood below.
IV		Moderate flood turning S. in Mud River.	Moderate flood	do	Moderate flood.
V		do	do	Moderate flood	Do.
VI	H. W	Slow flood turning N. in Mud River.	Slow flood	Slow ebb	Slow ebb above; slow flood below.
VII		do	Slow flood above; slow ebb below.	Moderate ebb	Strong ebb.
VIII		Slack water	Moderate ebb	Strong ebb	Do.
IX	Half ebb.	Strong ebb from S.	Strong ebb	do	Slack above; moderate ebb below.
X		do	do	do	Do.
XI		Moderate ebb from N. and S.	do	Slack water	Do.
XII	L. W	Slack water	Slow ebb	Slack above; slow ebb below.	Slow ebb.

It will be seen from the table that in Mud River below New Teakettle Creek there is found a slow ebb current at low water. For three hours there follows an area of slack water, gradually moving up stream, with ebb currents above and flood currents below it. For the succeeding two hours moderate flood currents prevail throughout, and at high water there is again an area of slack water, with slow ebb currents above and slow flood currents below. For two hours after high water strong ebb currents prevail. For the three succeeding hours there is an area of slack water in the upper portion, from which moderate ebb currents are flowing toward the Sound. At low water the cycle of changes begins anew. There are therefore seven hours out of twelve during which an area of slack water exists in some portion of Mud River, with slow or moderate currents in other portions, and only two hours during which strong currents exist, viz, the ebb currents for two hours after high water. At the mouth of New Teakettle Creek slack water occurs at low water. For three hours following the strong flood currents flow to the north and south on entering Mud River. For the next two hours they turn to the south only, and at high water and for two hours thereafter they turn to the north slowly and die out in high water slack. During the third and fourth hours after high water strong ebb currents enter the creek from the south; from that time until low water slack moderate currents from both north and south meet in the mouth of the creek.

During high water slack in the creek strong ebb currents are flowing across its mouth in Mud River. In the north end of New Teakettle Creek the maximum flood velocity is about 2 feet per second, with a bottom velocity of 1.7 feet at half flood. The maximum ebb velocity is about 2 feet per second at four hours after high water. At the shoalest part of the Mud River crossing the maximum ebb velocity is about 1.3 feet per second at one hour after high water, but the trend of the current is about 50 degrees away from the axis of the channel. The maximum ebb velocity when the water flows in the direction of the channel is only about 0.7 of a foot per second. The maximum flood velocity in the direction of the channel is only about 0.2 of a foot per second. Close to the mouth of New Teakettle Creek the ebb current in Mud River reaches a velocity of about 2.5 feet per second, but its direction makes an angle of nearly 50 degrees with the axis of the channel. In the channel of Mud River, half way between the mouth of New Teakettle Creek and Sapelo Sound, the maximum ebb velocity is about 1.6 feet per second. The flood currents were not measured at that point but appeared to be much weaker than the ebb. The channel through Mud River may be improved: (1) By dredging alone; (2) by dredging aided by works of contraction.

A dredged channel through the soft material composing the bottom of Mud River would soon be partially filled by material washed in by storms and cross currents. It would therefore be necessary to resort to dredging at frequent intervals in order to maintain the necessary depths. There are three shoals requiring deepening, which may be designated as the upper shoal, at the crossing from New Teakettle Creek; the middle shoal, near the mouth of the small stream entering Mud River from the west, and the lower shoal near the river's mouth. The upper shoal is about 1,500 feet long, with a minimum mean low-water depth of 4.8 feet and an average depth of 5.6 feet. The dredging of that shoal to a depth of 7 feet at mean low water and a bottom width of 50 feet will require the removal of about 8,000 cubic yards of material. The length of cutting at the middle shoal may be shortened one-half by cutting

across from the present channel to the deep water at the mouth of the small creek entering from the west. The length of cut on that line will be about 5,200 feet. The least depth of water is 3.4 feet and the average depth 5.3 feet. The deepening of that shoal will require the removal of about 30,000 cubic yards of material. To deepen it to 7 feet at mean low water on the line of the present channel will require the removal of about 35,000 cubic yards of material. The lower shoal is about 4,500 feet long, with a minimum depth of 5.2 feet and an average depth of 6 feet. The deepening of that shoal will require the removal of about 17,000 cubic yards of material, making a total of 55,000 cubic yards. It is impossible to predict the rate at which such a dredged channel will be filled by transported material, but experience gained in dredging at other places in similar material shows that the deterioration of the channel will doubtless be very rapid during the first two years. In that time it is probable that one-half of the original increase in depth will be lost. After that the shoaling will be less rapid. There will probably be little error in assuming that in one year after the dredged channel is completed an amount of material equal to one-third of that originally removed will have found its way into the cuts, to be again removed. The quantities of material requiring removal in succeeding years will doubtless decrease little by little, but it can not be assumed that a dredged channel in Mud River will ever be self-maintaining.

ESTIMATE.

Dredging, 55,000 cubic yards, in place, at 25 cents	$13,750.00
Engineering and contingencies, 15 per cent	2,062.50
Total	15,812.50
Annual expenditure for maintenance $4,000, equal to 5 per cent interest on	80,000.00
Aggregate	95,812.50

Should contracting works be constructed to maintain the dredged channel, the currents that will be mainly effective in maintaining the increased depths in the upper portions of the river are the strong ebb currents that prevail for two or three hours after high water. The contraction of the waterway necessary for the proper control of the currents and the maintenance of the channel involves the construction of about 9,500 linear feet of spur dams. They should have a wide foundation, to insure stability on the yielding bottom, and should be brought up to the level of half tide, or 3.7 feet above mean low water. Log or brush mattresses loaded with riprap stone should be used below low water, and stone alone above that level. Some oyster shells might be used to advantage in loading the mattresses, as they would probably promote a rapid shell growth. The cost of the improvement is estimated, in round numbers, at $197,000.

ESTIMATES.

Dredging, 55,000 cubic yards, in place, at 25 cents	$13,750.00
Mattresses, 64,000 square yards, at 75 cents	48,000.00
Stone, 28,500 cubic yards, at $3.50	99,750.00
Shells, 10,000 cubic yards, at $1	10,000.00
Total	171,500.00
Engineering and contingencies, 15 per cent	25,725.00
Aggregate	197,225.00

The survey was extended to include Front River, the upper part of Mud River to Scotts Creek, and a portion of Old Teakettle Creek, in order to develop two other possible routes, one by way of Front River, Scotts Creek, and Old Teakettle Creek, and the other by way of Front River, thence across the marsh through a dredged cut 3,400 feet long to Mud River, opposite the mouth of New Teakettle Creek.

For the improvement of the former route dredging only would be required. The cut connecting deep water in Front River with deep water at the mouth of Old Teakettle Creek should follow approximately the windings of the upper half mile of the river and of Scotts Creek, both of which would need deepening and widening. There are also two small shoals near the head of Front River and one near the mouth of Old Teakettle Creek that would require deepening. The total amount of material to be removed by dredging would be about 150,000 cubic yards in place. It is quite probable that considerable expenditures would be required for maintenance, possibly from $3,000 to $5,000 per year.

ESTIMATE.

Dredging, 150,000 cubic yards, in place, at 25 cents	$37,500
Engineering and contingencies, 15 per cent	5,625
Total	43,125
Annual expenditure and maintenance $4,000, 5 per cent interest on	80,000
Aggregate	123,125

The improvement of the second route through Front River would require the opening of a cut through 3,400 feet of marsh to a depth of 14 feet. A cut would also be necessary through the shoal in Mud River between the mouth of the marsh cut and the mouth of New Teakettle Creek. A high dam on the eastern side of this channel, closing Mud River, and a low sill dam on the western side would be necessary to direct the currents in the direction of the channel and to keep out the mud which would otherwise fill the cut under the action of the cross currents. The improvement, once completed, would probably be self-maintaining.

ESTIMATES.

Dredging, 200,000 cubic yards, in place, at 25 cents	$50,000.00
Mattresses, 42,500 square yards, at 75 cents	31,875.00
Stone, 19,000 cubic yards, at $3.50	66,500.00
Shells, 7,000 cubic yards, at $1	7,000.00
Total	155,375.00
Engineering and contingencies, 15 per cent	23,306.25
Aggregate	178,681.25

The most desirable route of all those mentioned is the one just described, since its improvement would doubtless be permanent, but the immediate outlay required for giving a channel 7 feet deep at mean low water through Mud River by dredging alone being only about $16,000, that route is recommended for improvement. When the commercial, military, or naval necessities of the country require a deeper channel than 7 feet along the inside route to Florida, the last route described will doubtless be adopted.

LITTLE MUD RIVER.

The next point to the southward having an insufficient depth of water is in Little Mud River, where a short shoal exists about 4,000 feet from

the mouth. The river widens out excessively where it joins Altamaha Sound, and the narrow channel lies close along the eastern shore with depths of from 7.2 to 9.6 feet, except at the point mentioned, while west of the channel is a broad mud flat over which the depths are from 1 foot to 3 feet. Near the mouth of the river, where the channel depth is but 7.2 feet, the 7-foot curves on either side approach each other so closely as to cause some difficulty in low-water navigation.

In the deeper portions of the channel the bottom is composed of stiff mud, mixed with clay. In the shoaler portions a softer mud is found, and on the mud flat the bottom is very soft.

The mean range of tide, as approximately determined by only a few observations, is about 6.7 feet. The tidal currents on the day they were observed moved to the south slowly at high water, and continued to do so for about four hours thereafter, when they changed to the north, soon became strong, and lasted until about two hours after low water, when they slackened and again turned to the south. There were therefore strong northerly currents for about four hours, and weak southerly currents for about eight hours out of the twelve. The observations were made, however, during a freshet in the Altamaha River, and during a strong wind from the west and southwest. The above results are therefore probably somewhat abnormal. The observed maximum velocity of the northern current was 1.4 feet per second with a bottom velocity of 1.1 feet, and that of the southerly current about 0.5 of a foot per second with a bottom velocity of 0.2 foot.

A comparison of the present survey with former ones shows that the river near its mouth is gradually narrowing, and at a point 4,000 feet from the mouth is only about one-half of its former width. The depths have at the same time increased. At the mouth of the river, where formerly a channel depth of but 4 feet was shown, there is now a depth of from 8 to 9 feet at mean low water. The only works of improvement required here are the deepening of the shoal 4,000 feet from the mouth by the removal of about 2,000 cubic yards of material and a slight widening of the channel near the river's mouth by the removal of about 1,000 cubic yards, which would cost, in all, about $1,000.

Since the channel is deepening through natural agencies, it is probable that the improved channel would be self-maintaining.

JEKYL CREEK.

Jekyl Creek connects St. Simon Sound on the north with St. Andrews Sound on the south. It is about 5 miles long and carries ample depths except near the northern end, where two shoals exist, one just outside the mouth, where the channel crosses a mud flat to reach deep water in Brunswick River, and the other about 1 mile from the mouth, where the widths are excessive and where the creek is joined by Mud River. The outer shoal is about 2,000 feet long, with an average mean low-water depth of 5.6 feet and a minimum depth of about 4.8 feet. The inner shoal is about 3,000 feet long, with an average low-water depth of 6 feet and a minimum depth of about 5.3 feet. The material composing the bottom on the outer shoal is very soft mud, and that on the inner shoal mud ranging from soft to stiff.

The mean range of tide in the creek, as determined by the limited number of observations available, is 7.1 feet. The tidal currents in the northern end of the creek are quite irregular and are largely affected by the force and direction of the wind. A stiff northerly wind will cause a southerly flow in the northern end of the creek throughout the

whole tide, but a southerly wind does not produce the opposite effect of constant northerly currents, the flood current being southerly and the ebb northerly.

Under normal conditions the current is toward the south during the entire flood and during a part of the ebb tide, and toward the north during only a part of the ebb tide. The preponderance of flow is therefore toward the south. The stormy weather that prevailed during the survey of Jekyl Creek prevented a satisfactory determination of its current velocities, but former observations show them to be sufficient, if properly controlled and directed, to maintain the required depth in the channel when once obtained.

Jekyl Creek has already received attention from the General Government, a project for its improvement having been prepared by General Gillmore, the engineer then in charge, and printed as Appendix No. 10, Annual Report of the Chief of Engineers for 1888.

It provides for—

(1) A training wall at the mouth of the creek, designed to guide and concentrate the ebb currents across the mud flats to the deep water of Brunswick River.

(2) A closing dam across Mud River, to prevent the escape of water through that estuary.

(3) Dredging across the mud flats at the entrance to Jekyl Creek and in the creek proper near the mouth of the river.

The training wall and closing dams are to be constructed of log or brush mattresses, brush fascines, and riprap stone below the level of low water; stone alone to be used above that level.

The cost of the improvement was estimated at $38,590. An appropriation of $5,000 was made for the work in 1888 and another of $7,500 in 1890. Such inadequate and infrequent appropriations increase the cost of the work and much dredging will have to be done again, because it has been impossible, with the limited amounts available, to construct the training wall and dam necessary to maintain the acquired depths. All of the first and part of the second appropriation were expended in dredging. The remainder of the second appropriation was expended in the construction of 513.5 linear feet of foundation course of the training wall across the outer shoal. To complete the work will require the expenditure of $35,000, the increase in the original estimate being made necessary by the inadequate appropriations heretofore made.

For further details in connection with the work of improving Jekyl Creek I respectfully refer to Annual Reports of the Chief of Engineers for 1888 *et seq.*

THE DIVIDINGS.

Cumberland River, branching from St. Andrews Sound, and the long arm of Cumberland Sound meet at the mouth of Crooked River. The tides from opposite directions meet there on the flood and part on the ebb, and the point is therefore known as "The Dividings." A sand spit extends from the Cumberland Island shore toward the mouth of Crooked River, causing the channel to curve in the shape of a horseshoe and giving to the point the name of Horseshoe Shoal. The length of the horseshoe-shaped portion of the channel is about 3,000 feet, and at its narrowest point the 7-foot mean low-water curves are fully 100 feet apart. The minimum channel depth is 7.3 feet and deeper water of from 8 to 10 feet is found in both directions within 200 feet of the shoalest point. The river bottom in or near the channel is composed of sand and mud, or sand and clay, and is quite firm. The shoal is composed

mostly of sand. The mean range of tide is approximately 7 feet. It was determined by the readings of one high and one low water each day from March 27 to May 1, 1891, corrected by comparison with predicted tides at Fort Clinch (Cumberland Sound) and St. Andrews Sound. The above determination errs, if at all, on the side of excess, and probably by not more than 0.2 of a foot.

A gauge was read for the same period at Cumberland wharf, giving the mean range at that point, under the same limitations, as 6.9 feet. The mean tidal range in St. Andrews Sound is 6.8 feet and at Fort Clinch 5.9 feet.

At low water ebb currents are still flowing from Crooked River strongly into Cumberland River and very feebly into Cumberland Sound. Flood currents then begin in Cumberland Sound and for nearly two hours divide and enter both Crooked River and Cumberland River, causing a northerly flow across Horseshoe Shoal. Two hours after low water slack water occurs at the head of Cumberland River, and all of the flood from Cumberland Sound enters Crooked River. During the third, fourth, and fifth hours of the flood the currents from both Cumberland Sound and Cumberland River meet at the point of the horseshoe and enter Crooked River. Ebb currents are established first in Cumberland Sound shortly after high water, and for nearly two hours a southerly flow takes place across the point of the horseshoe from Cumberland River to Cumberland Sound, and at the same time the ebb currents from Crooked River, beginning about one hour after high water, flow also to the south.

Slack water occurs at the head of Cumberland River at two hours after high water. During the third, fourth, and fifth hours of the ebb the currents from Crooked River divide at the point of the horseshoe and flow to the north in Cumberland River and to the south in Cumberland Sound.

The maximum observed flood (southerly) velocity in the channel at the head of Cumberland River, just north of the Horseshoe, was 1.2 feet per second with a bottom velocity of about 1 foot. The maximum ebb (northerly) velocity at the same point was 1.4 feet per second, with a bottom velocity of about 1.2 feet. In the deep pocket near the Cumberland Island shore the maximum flood velocity was 1.3 feet per second and the maximum ebb velocity 0.9 of a foot per second.

At the head of Cumberland River the approximate total flood flow through a section 1 foot wide and 12.2 feet deep at mean low water was nearly 350,000 cubic feet, and the total ebb flow through the same section was approximately 290,000 cubic feet, the excess of 60,000 cubic feet toward the south being due to the greater mean elevation of the water surface during the flood currents. The average depth at the point considered during flood currents was 17.5 feet, while during ebb currents it was but 14.7 feet.

In the deep pocket near Cumberland Island the total flood flow through a similar section 9 feet deep at mean low water was about 276,000 cubic feet and the total ebb flow was nearly 150,000 cubic feet, the excess there being also toward the south, and amounting to about 126,000 cubic feet. It is probable that on the day the observations were taken the flow toward the south at the head of Cumberland River exceeded that toward the north during one entire tide by more than 100,000,000 cubic feet. The observations were not extended enough, however, to determine the influence of the wind, which is probably considerable. They were made when the range of tide was normal, the direction of the wind not being reported. In the absence of more com-

plete evidence the above results are assumed to be approximately correct, although more extended observations might change them materially. Great changes have taken place in this vicinity within the last few years. The Coast Survey charts show that an island once existed in the middle of the river, opposite the mouth of Brickhill (Kiln) Creek. The island has been entirely washed away. It is said to have shown above low water not more than ten years ago, but in its place there is now a depth of from 4 to 13 feet of water. A former channel depth of 7 feet north of the Horseshoe has increased to 9.5 feet, and at the point of the shoal a former depth of 6.2 feet has increased to 8 or 9 feet.

The survey shows that there are now ample depths at that point. Should any difficulty be experienced in making the turn around Horseshoe Shoal it can be avoided by entering the mouth of Crooked River, where the 7-foot mean low-water courses are 800 feet apart, affording ample room for turning and starting into the opposite branch of the curved channel. The channel should be marked by range lights and buoys. No works of improvement are therefore recommended at The Dividings.

SUMMARY.

The survey just made discloses the fact that to establish a continuous channel not less than 7 feet deep at mean low water between Savannah, Ga., and Fernandina, Fla., will require works of improvement at four points, viz, Romerly Marsh, Mud River, Little Mud River, and Jekyl Creek. The expenditures involved are, in round numbers—

Romerly Marsh	$63,000
Mud River	96,000
Little Mud River	1,000
Jekyl Creek (completion)	35,000
Total	195,000

If the estimated cost of maintenance be not included, the above estimate becomes—

Romerly Marsh	$53,000
Mud River	16,000
Little Mud River	1,000
Jekyl Creek (completion)	35,000
Total	105,000

COMMERCE.

The inside route is of great value to the coasting trade between Savannah and Fernandina, and the intermediate points. A regular line of steamers plies the entire route, making semiweekly trips. Another line is established between Savannah and Darien, making three trips per week. A small steamer makes daily round trips between Brunswick and Darien, and on the Cumberland route a daily round-trip schedule is maintained between Brunswick and Fernandina, connecting at Brunswick with the Brunswick and Western and the East Tennessee, Virginia and Georgia railways. The above-named steamers carry passengers as well as freight. There are also a number of small freight steamers making irregular but frequent trips between the Ogeechee, Altamaha, and Satilla rivers, and the ports of Savannah, Darien, and Brunswick. Other small steamers are engaged in the oyster and fishing business, and ply between the numerous oyster beds

and fishing grounds along the inside route, and the several coast cities. A large fleet of sloops and schooners of from 25 to 50 tons burden bring oysters, fish, rice, and shells from points along the inside route to the cities, and a number of barges, towed by tugboats, are used in transporting the products of the sea and of the coast plantations to the city markets. Large vessels are often towed from port to port without cargo or ballast by the inside route, when it would be impossible for them to reach the desired port by sea without taking in ballast; and partially loaded vessels often take the inside route to another port to complete their cargoes, thus avoiding rough weather at sea. About 25,000,000 feet of lumber are annually rafted and towed from the mouth of the Altamaha River to Sapelo Sound and St. Simon Sound for shipment in deep-draft vessels to foreign ports.

It is difficult to estimate the actual amount and value of the commerce dependent upon the inside route, owing to its varied character and to the fact that much miscellaneous freight is carried by the package, its weight and value not being known. Moreover, repeated applications to the owners of some of the boats plying those waters for information concerning the traffic of their boats have elicited no response, and in such cases the amount of traffic can only be roughly estimated. The steamers of the Sea Island and the Cumberland routes and the other regular lines draw not over 6 feet of water. The tugboats engaged in rafting lumber and in towing vessels, barges, and lighters draw from 7 to 10.5 feet, and vessels under tow often have the maximum draft that can be carried through the portion of the route they traverse.

The freights carried outward from the cities along the inside route are mainly general merchandise, commercial fertilizers and guano, mill and camp supplies. The freights collected along the route and brought to the cities consist of cotton, rice, naval stores, vegetables, fruit, oysters, fish, and shells.

Commercial statistics were collected with reference to the points at which work of improvement would be necessary and an estimate, based on the most reliable sources of information available, is given in the following table:

Through.	Number of trips.	Tons of freight.	Value of freight.	Number of passengers.
Romerly Marsh	820	51,000	$1,020,000	10,000
Mud River	1,460	60,800	970,000	3,000
Little Mud River	570	28,000	325,000	4,000
Jekyl Creek	2,520	45,000	955,000	26,000
The Dividings	1,080	19,000	460,000	11,000

The above table does not include the commerce of the boats of less than 20 tons burden or the tonnage of the towboats engaged in towing vessels and lighters. Some of the commerce included in the above table passes two or more of the points under which it is grouped and is therefore counted more than once. Considering the route as a whole, the total traffic during the year ending June 30, 1891, was approximately as follows:

Number of trips	4,900
Tons of freight carried	156,000
Value of freight	$2,787,000
Number of passengers	41,000

The improvement of the shoals which now obstruct navigation on the inside route would render possible a much better passenger and freight service than is now maintained. The boats of the regular lines would then be able to run on schedule time, and not be compelled to wait for a suitable stage of tide for crossing the shoals. The boats of the Cumberland route carry the United States mails as well as passengers and freight, and are so run as to connect with the Florida Central and Peninsular Railway at Fernandina, and the Brunswick and Western, and the East Tennessee, Virginia and Georgia railways at Brunswick. Those boats are frequently delayed at Jekyl Creek, and great inconvenience and loss are caused by the consequent interruption of the schedule. There can be no doubt that the opening of a continuous channel not less than 7 feet deep at mean low water between Savannah and Fernandina would be followed by a great increase in the annual commerce of the inside route.

The importance of the route for military and naval purposes has already been mentioned in former reports. The improved channel will be available for gunboats and transports drawing from 12 to 14 feet of water, and it would particularly favor the operations of our torpedo boats against hostile vessels. Exits to the sea are afforded at intervals of from 5 to 15 miles through the numerous sounds that indent the coast, from which those boats could dash forth, strike a sudden blow, and returning, find close at hand a safe harbor secure from attack and from storms.

If the recent recommendations of the general commanding the Department of the East in regard to the defense of the South Atlantic ports by means of a strongly fortified central station, including Port Royal Harbor and Tybee Roads, be carried into effect, then the importance of the inside route as an adjunct to such defense can scarcely be overestimated, and whatever may be the plan of defense adopted for those ports the inside route will be a potent factor in its efficiency.

An effective blockade of the Southern ports by a foreign fleet would be practically impossible, because light-draft vessels could enter or leave at any of the sounds along nearly 200 miles of the coast and reach the desired seaport by the inside route.

In view of the great commercial value of this route, as well as of its military importance and of the comparatively insignificant expenditures involved as compared with the benefits to be derived therefrom, I am of the opinion that "the inside route between Savannah, Ga., and Fernandina, Fla., with a view to obtaining a steamboat channel of 7 feet depth at mean low water," is worthy of improvement.

Irregular and inadequate appropriations will greatly increase the cost of the work and delay its completion, and it is therefore recommended that unless the total sum required for its completion, viz, $105,000, can be appropriated at one time no appropriation for the work may be made.

APPENDICES.*

1. Map of "New Cut" and part of Wassaw Creek, Romerly Marsh. Scale: 1 : 1200.
2. Map of Habersham Creek and vicinity, Romerly Marsh. Scale: 1 : 1200.
3. Map of Mud River and vicinity. Scale: 1 : 4800.
4. Map of Little Mud River. Scale: 1 : 4800.
5. Map of Jekyl Creek. Scale: 1 : 4800.
6. Map of The Dividings, Cumberland River and Sound. Scale: 1 : 4800.

*Not printed.

7. Diagram of directions and velocities of currents in New Cut and Wassaw Creek, Romerly Marsh. Scale: 1 : 1200.
8. Diagram of directions and velocities of currents in Mud River. Scale: 1 : 4800.
9. Diagram of directions and velocities of currents at The Dividings. Scale: 1 : 4800.

Respectfully submitted.

O. M. CARTER,
Capt., Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

(Through Col. William P. Craighill, Corps of Engineers, Division Engineer, Southeast Division.)

[First indorsement.]

U. S. ENGINEER OFFICE,
Baltimore, Md., November 30, 1891.

Respectfully submitted to the Chief of Engineers.
I concur in the recommendations of Captain Carter.

WM. P. CRAIGHILL,
Colonel, Corps of Engineers.

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